The new road at Budd Lake, Route 5

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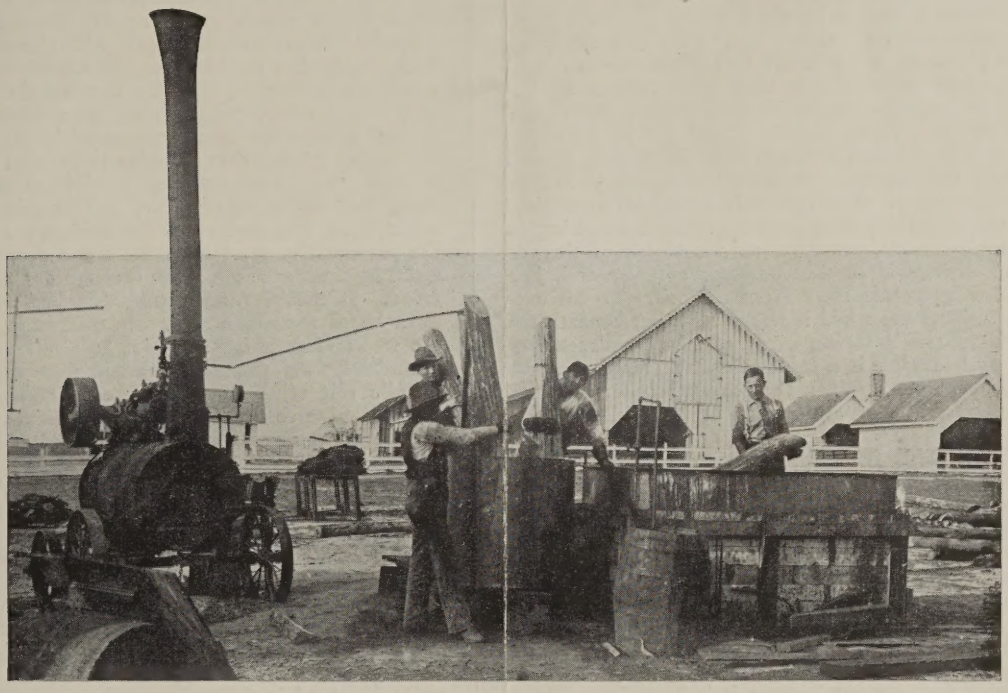


Open tank for treating the butts of posts with Protexal Wood Preseravtive, utilizing exhaust steam from a traction engine for heating the preservative.

Note

The papers presented at the recent Convention of the New Jersey Highway Association, and the discussions following them, are such a valuable contribution to the progress of road-building that it has been decided to publish them in full with as many as possible of the charts and illustrations used. (It has not been possible to include all of these, however, so there are occasional references in the text, to photographs and charts which have not been reproduced).

Our aim is to publish one or two of the Convention papers, with the discussion thereon, each month. We suggest that these be carefully filed, so that the reader may keep the complete set, which will make a very valuable addition to his road-building library.

This month we are printing "The Proper Treatment of Posts for Guard Rails", by Edward F. Paddock, Protexol Corporation, and the discussion thereon at the convention; also "The Advantages and Objections of a Sheet Asphalt Pavement With and Without a Binder Course," by Abram Swan, City Engineer, Trenton, New Jersey, and the discussion thereon at the convention, and "Contract News" prepared to August 24, 1922.

Next month there will be published "Refined Tars in Maintenance and Construction", by Phillip P. Sharples, Technical Adviser, The Barrett Company, and the discussion thereon at the convention; "Purposes and Practices of the Asphalt Association", by Joseph R. Draney, President of the Asphalt Association, New York City, and the discussion thereon at the convention; and Contract News.

The Proper Treatment of Posts for Guard Rails

By Edward F. Paddock
Protexol Corporation

Guard rail posts are exposed to particularly severe conditions and are subject to a number of dangerous and very contagious diseases known collectively and indiscriminately as rot or decay.

Mr. Wasser has asked me to tell you something about the "How" of fighting these diseases.

In order that we may more clearly understand the nature of preservative treatment, it is essential that we know something of the nature of the diseases that we are combatting and I wish therefore to state briefly how and why guard rail posts decay.

Rot in timber is caused by the presence of fungi, or as they are more commonly called toad stools or mushrooms. These are plants of a low order that grow not on but in the wood. Like other plants, they grow from seed, but from seed so small as to be invisible to the naked eye, except in masses. These seeds or spores are in the air at all times and are washed down by the rain or dew, so that the moisture that comes in contact with posts is full of them. When one of these spores is deposited on a piece of wood, under suitable conditions it germinates and begins to grow in the wood, sending out a network of threads which find their food in the substance of the wood, just as a plant takes nourishment from the soil. To all outward appearances the wood is unchanged, but beneath the surface the fungus is taking away certain constituents of the wood and leaving it a mass of soft material that we know as rotten wood. When the fungus reaches maturity its next business is the reproduction of its kind and it is only then that we become aware of its presence. It begins to bear fruit. This fruit appears on the surface of the wood in the form of toadstools, mushrooms, punks or conks which soon begin scattering seeds by the million and the process begins again.

Two things are to be borne in mind. The mushroom does not appear until the wood is already rotten and the mushroom is not the fungus, but only its fruit.

Like all other plants, fungi require moisture, air, a suitable temperature and food. Remove any one of these essentials and the fungus cannot develop. The furniture in our houses does not rot because it is kept dry. Wood completely and continuously kept submerged in water does not rot because it is kept from contact with air. Wood kept continually very hot or very cold does not rot because fungi can live only within certain limits of temperature.

In the case of guard rail posts, however, these conditions are not within our control. The post is set in the ground where it is almost continually damp and where the moisture in the wood has little chance to evaporate. It is exposed to the air above and often for some distance below the ground line. Our climate furnishes temperatures that are suitable for fungus growth. There remains only the food supply and this being the post itself, cannot be removed. The only thing left for us to do is to prevent fungus spores from coming in contact with the wood, or to so poison the wood that fungus spores coming in contact with it will not germinate. This is the business of the wood preservative, to form an unbroken antiseptic zone about the wood or at least such a portion of it as is unprotected and would provide suitable soil for the development of fungi.

The simplest form of wood preservative is paint. If the wood is free from fungus and fungus spores, which it rarely is, a coat of paint will keep new spores from reaching the wood and so prevent rot just as long as the coating of paint remains whole and unbroken, but no longer. As soon as the paint film is scratched through or broken in any way, fungus spores can reach the wood and do reach it as we all know, for painted wood does rot, and when decay has once started all the painting we can do will not help it.

Only a little better than painting is the coating of the wood with hot tar. The only advantages that this has over painting are that the heat of the tar when applied may kill any fungus or fungus spores that lie at or near the surface of the wood and being applied hot, a little of the tar will penetrate the outer cells of the wood and so make it a little more difficult to break through the protective coating. When the tar cools, however, it is easily cracked or injured and then decay can start.

Another method of preventing decay has been repeatedly tried and it appeals on account of its simplicity. I refer to charring. It was thought that by subjecting the outer portion of the wood to fire, not only the fungus in it would be killed but that the outer portions of the wood would be partially distilled, leaving preservative materials in the wood. This sounds very plausible but experience has repeatedly shown that not only will charred wood decay very readily but further, that the substances distilled from wood and known as wood tar and wood tar creosote have very little preservative value even when used in far greater quantities than are produced in charring the wood.

It appears then, that in order to prevent decay we must in some way poison the outer portions of the wood so that fungi will not grow in it and so that this protective antiseptic zone may not easily be broken. This means that the preservative must enter the wood deep enough so that ordinary wear will not break through and expose untreated wood. It means further that this preservative material must be of a permanent nature so that it will remain in the wood after it is put there.

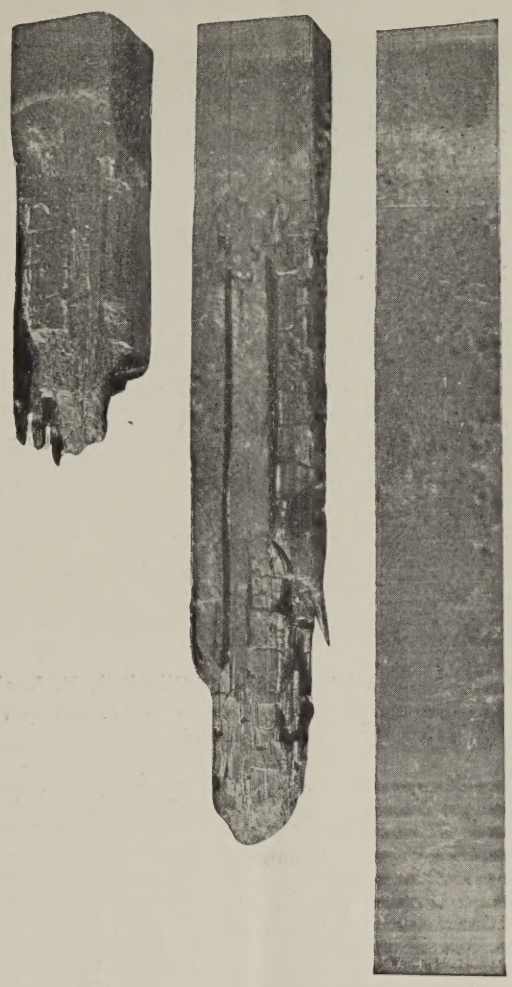
Probably the cheapest and simplest preservatives are metalic salt solutions, such as copper sulphate, mercuric chloride, zinc chloride and sodium fluoride. These are all soluble in water and are applied in water solution. They are injected into the wood under pressure or absorbed by immersion in baths of the preservative. After the treatment the water evaporates leaving the preservative salts in the wood.

This is all very well for wood that is to be used in comparatively dry situations but where the wood is to be embedded in the ground and will be in contact with earth that is damp for the greater part of the time, they have not proven successful. Under such conditions the process known as leeching takes place, whereby the salts are gradually dissolved in the moisture of the surrounding soil and carried away from the wood so that in a comparatively short time the preservative disappears from the wood leaving it unprotected.

There is, however, a class of preservatives that are only very slightly soluble in water and which at the same time are extremely poisonous to fungi. These are the heavy oils distilled from coal tar and known as dead oil or creosote and green or anthracene oil. Many years of experiment and actual experience have demonstrated the efficiency of these coal tar distillates so that today they are recognized as the very best means of prolonging the life of wood under all sorts of conditions of exposure.

Now just what are the conditions that a guard rail post must meet, as far as decay is concerned? First, it is set in the ground so that the lower three feet of it are surrounded by earth. As we know, earth, even in well drained sand, never dries out more than a few inches below the surface so that the post below the ground line is kept continually moist. The exposed upper part of the post has plenty of air but remains dry. The earth in which the butt of the post is embedded is sufficiently porous to provide an air supply to the post for some distance below the ground line. In clay, this may be only an inch or two, while sand or gravel may be sufficiently porous to allow air to reach the very bottom of the post. Where the posts are shaded by grass and weeds, they frequently remain damp for several inches above the ground line. We see then that just above and below the ground line there is a zone where fungi have just the conditions necessary for their development and that this zone may extend slightly above the ground line and may include the entire lower end of the post.

The coal tar preservatives of which I have spoken consist of a very complex mixture of chemical compounds.



Three 8x8 *inch long leaf yellow pine post butts from a stock pen fence on the Missouri Pacific Railway, at Pueblo, Colorado.*

1. *Untreated. Completely decayed below the ground line.*
2. *Received one brush coat of Protexol Wood Preservative, one foot above and one foot below the ground line. Sound as far as the treatment extended*
3. *Immersed for* 10 *minutes in heated Protexol Wood Preservative. Perfectly sound after* 11 *years.*

All three posts were set under identical conditions in 1902 *and removed in* 1913. *All specimens cut off one foot above the ground line.*

Some of these compounds evaporate readily and consequently do not remain long in the wood, while others are of such high boiling points that they will practically not evaporate at all at ordinary temperatures, or even at the temperatures used during treatment. Here then is the difference between creosote and anthracene oil. Creosote contains a large proportion of volatile constituents while anthracene oil consists almost entirely of nonvolatile oils that remain permanently in the wood. It would seem then that when creosote is used as a preservative we must anticipate that a large portion of it will disappear when it is exposed to the air. Experiment has proven this to be true and also that the portion that does remain permanently to preserve the wood, consists of the high boiling nonvolatile oils, the anthracene oils.

In the preservation of railroad ties, about a gallon of creosote per cubic foot or roughly, a pound and a half per square foot of lateral surface is found to be necessary to insure proper protection. This is forced into the wood by means of pumps in a tight cylinder. Obviously the entire surface of the wood is treated. In the case of guard rail posts this is out of the question, because for several reasons the surface of the post above the ground must not be oily. If it were, it would be impossible to paint it white, for the creosote would quickly destroy the color. If it were oily, it would soil the clothing of anyone coming in contact with it. Since it is exposed to the air it is for the most part dry and will not readily rot, so that one-half of the treatment would be wasted.

Our treatment then must be confined to such portions of the post as are exposed to decay. Two methods of application present themselves, brushing, and immersion in an open tank of the preservative. Obviously, it is impossible to put a pound and a half of creosote or anything approaching this quantity in every square foot of surface with a brush. With open tanks it is possible but only by means of treatments lasting so long as to make them impracticable. Where any appreciable amount of posts are to be treated this means days or weeks of labor or large tank capacity both for treatment and storage of preservative.

This brings us to the anthracene oils which on account of their non-volatile nature remain permanently in the wood and which consequently can be used in much smaller quantities to obtain the same results. The higher the specific gravities and boiling points of these oils, the more permanent they are and the less is required for preservation. Protexol Wood Preservative is not only the highest boiling distillate of coal tar commercially obtainable but it is modified by filtration to make it liquid at ordinary temperatures and by treatment with chlorine to increase its viscosity and specific gravity, to raise its flash and burning points, and to make it still more poisonous to wood destroying fungi.

Comparable tests of anthracene oils, creosote and other preservatives have invariably shown the superiority of the high boiling permanent oils. Such tests have been performed not only in this country but in France, Austria, Germany and India with always the same result.

One very extensive test was made in the Bellevue Mine

Untreated chestnut pole on Westfield Ave., Elizabeth, N. J., showing fruiting body of an edible, wood destroying fungus. Polyporus Sulphureus, at the ground line

at Scranton, Pa., in which Protexol Wood Preservative and creosote were used and in which the published results showed that the high boiling anthracene oil was slightly superior to the creosote. What the published reports do not show is brought to light in an analysis of the record of the treatment that was furnished to those co-operating in the test. From such an analysis we find that about five times as much creosote was used per cubic foot of timber as was used of Protexol Wood Preservative and moreover while the open tank treatments with this material required from thirty minutes to an hour and a half, those with creosote lasted from four to thirty-nine hours. In other words, while the cost of the preservatives used was approximately equal the labor and time consumed averaged more than ten times as great for the creosote treatments as for those with Protexol Wood Preservative and five times as much preservative had to be shipped, handled and stored.

For guard rail posts I would unquestionably recommend what is known as the "Hot and Cold" or double immersion treatment with Protexol Wood Preservative. The apparatus necessary consists of two tanks about three feet in diameter and four feet six inches deep. The bottoms of these tanks should be protected from injury by laying pieces of "I" beam or rail in the bottom. One of these tanks should be provided with steam coils or be so mounted that a fire may be built beneath it. The other, which is for the cold bath, should be provided with a draining platform on which the treated posts may be stood to allow the surface oil to run off and be returned to the tank. Such tanks as these are readily portable and may even be mounted on a steel truck so that the treating may be done either at the storage yard or on the job.

The process consists in filling the tanks to such a depth, that while the posts are being treated they will be covered to a depth of 3 ft. 8 in. The oil in the first tank is heated to about 180 degrees F. and held at this temperature throughout the treatment. The posts should be kept submerged in this bath for twenty minutes, then removed and immediately placed in the second tank containing the cold preservative. They should remain in this tank for ten minutes and finally removed to the draining table where they will in a few minutes become dry enough to handle.

Much lighter treatments than this have more than doubled the life of fence posts but particularly where oak and chestnut are used, the preservative absorbed by the posts is so little, that the added cost of the longer treatment is more than offset by the absolute assurance of a thorough treatment.

The equipment that I have described is capable of treating ten posts at a time and allowing five minutes for each charge to remove the treated posts and replace them with untreated posts, will treat 180 posts in an 8 hour day.

So far, I have spoken only of that portion of the post from the ground line down. There are, however, portions of the exposed post where decay is likely to occur. Your posts have their tops sawed at an angle and the top rail is fastened so that it rests on this sloping top. Whenever it rains moisture collects in the space between the top rail and the top of the post and is absorbed by the post. This surface being protected by the rail dries out very slowly and consequently the tops of the posts frequently decay. The same is true of the contact surface where the lower rails are nailed to the side of the post or within the holes through which cable is passed. Such contact surfaces and joints should receive protection. Personally I would sacrifice appearance and at least brush treat all such surfaces with hot Protexol. Another way would be to give the entire exposed portion of the post an open tank treatment just as the bottom was treated, using instead of the oil, a solution of sodium fluoride. This would give complete protection against decay and the posts could still be painted white without danger of discoloration.

In conclusion I wish to impress upon you a few fundamental rules that are applicable to preservative treatments of any kind.

A treatment is effective only so long as the preservative remains in sufficient quantity in the wood. As soon as it is removed through leeching evaporation or from any other cause, decay can begin. Too great care cannot therefore be given to the selection of a preservative that is of a permanent and abiding nature.

A treatment is effective only so long as the antiseptic treated zone remains unbroken. It is necessary, therefore, to do all framing before the timber is treated to avoid the danger of cutting through the treated zone and exposing untreated wood. Where cutting into treated wood is unavoidable all cut surfaces should receive at least two brush coats of the preservative to guard against the danger.

Preservative treatment will keep sound wood sound but it will not make sound wood out of rotten wood. It is necessary, therefore, to make sure that timber is free from rot before treating it.

Finally, live up to the letter of your specifications for treatment. A heavy treatment on one post does not make up for a light treatment on another.

Charred post showing decay below ground line after four years in service

Discussion of Mr. Paddock's Paper

By Mr. C. F. Bedwell, Construction Engineer New Jersey State Highway Department.

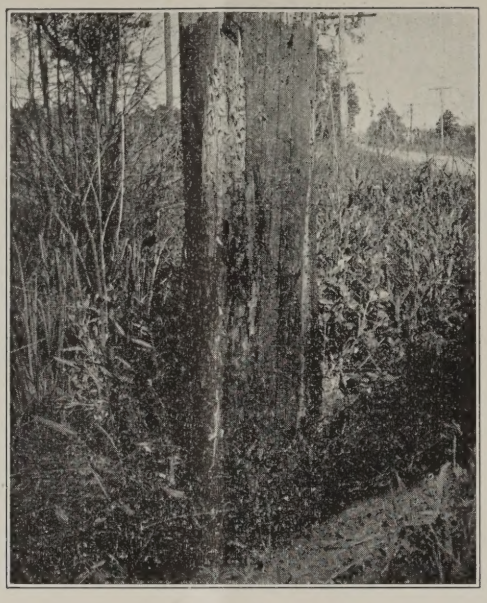
After hearing what Mr. Paddock has to say, we are bound to realize that the life of a mere, insignificant guard rail post is a serious matter, and in order that the post may continue to perform its function in carrying the guard rail, we must evidently in turn do all we can to preserve its health and well-being. In other words, we must realize that even a post must have its feet protected against dampness, and accompanying ills, the same as some of us wish we had done for ourselves after a bad attack of Flu, or possibly something worse, has laid us out.

Mr. Paddock has professed to be the Doctor who has the one and only sure preventative for diseases to which posts are subject and I personally believe he is quite right in most everything that he says and he has covered the subject in such a thorough and capable manner that there appears to me to be very little left to talk about. There may be great differences in opinion as to what is the best material and method to be used in the preservation of woods used for guard rail posts, but there is no question that a mere surface coat of paint or tar does not turn the trick, and undoubtedly some material must be used that will not only coat the surface of the post with an antiseptic preservative, but at the same time penetrate the wood to a sufficient extent so that a slight abrasion of the surface will not lay bare untreated wood. It has been demonstrated that perfectly practical, easy and economical methods of treatments can be accomplished with the open tank method in the field, and sufficient penetration obtained for all practical purposes and at a moderate cost.

When it was possible to easily and cheaply obtain local hard woods, such as white oak and live chestnut, it was not considered necessary to treat the fence posts with anything but a casual dipping or giving the bottoms of the posts a brush treatment with either dead oil, Creosote, or some of the anthracene oil compounds now on the market. In fact, it was not practical to do anything else with the hard woods, as in order to get penetration that amounted to anything, very extensive and expensive appliances were required, and furthermore a white oak or chestnut post dipped or brushed would last for a considerable time in the ground. Now, however, that the use of southern yellow pine for posts is becoming general, not particularly because of choice, but due to necessity and convenience, it is necessary that a more thorough treatment be given and fortunately, owing to the more porous nature of the yellow pine it is easier to get greater penetration of a preservative by using hot and cold emersions in open tanks. The posts can readily be dipped or treated with preservative up to a line just below the bottom of the lower guard rail, or location of the lower cable, in case wire cable is used instead of boards. That part of the post above the ground line and the bottom rail or cable, as the case may be, could then be readily coated with some black paint that would cover and hide the oil stains caused by the preservative; in fact, I think the blackening of that part of the post between the ground line and bottom rail adds to the appearance in day time and it helps in a way to make the whitened portion of the post and railing stand out more prominently at night.

I am sorry that I cannot go along with Mr. Paddock's recommendation that the entire post be treated and all framing be done to the posts prior to their treatment. First off, I personally prefer the use of Creosote or anthracene oil for preservative and for this reason the treatment must of necessity not extend very far above the ground line, because of the need of application of white paint to the posts and guard rail; and again, even if some treatment is given to the entire post, such as with Sodium Fluoride or Zinc Chloride, that would permit the application of white paint, and the framing of the posts prior to treatment and setting could not be done because of the fact that a post must be planted on a firm bottom, and not set to a line, which consequently necessitates that the posts be framed after being placed. Of course, there is no reason why that part of the post which has been cut for framing purposes cannot be treated with a preservative after being framed and before the railing is attached.

The railroad companies, with their ties and fence posts; and the telephone, telegram and electric light companies, with their poles, have long since learned, by sad experience, that the prevention of diseases and maintenance of good health of wood that is under ground, is of paramount importance and is an item of construction that is not to be slighted or lightly taken because of its seeming insignificance. It, therefore, behooves us to keep in mind always that an ounce of prevention in this particular case is worth pounds of cure, and I am sure my highly esteemed maintenance friends will bear me out in that statement, more certainly if an expenditure of less than 10% of the cost of the post will more than double its life.



Cedar pole painted with tar. All sap wood decayed to a height of 3½ feet above the ground line after only four years of service

General Discussion of Mr. Paddock's Paper

MR. KEASBEY: I would like to inquire as to the approximate cost per post for treating as Mr. Paddock outlined.

MR. PADDOCK: The cost will depend very largely upon the number of posts treated. The material I refer to particularly varies in price according to the quantity that is used. Your equipment will also vary according to the number of posts you are treating, but in single barrels this material can be purchased for about 90 cents per gallon. For the State Highway Commission, who would purchase in large quantities, the price, of course would be very much reduced. Even by purchasing the material in single barrels for use on farms or for home use, the cost had not ought to exceed from 15 cents to 20 cents a post, that is for chestnut, particularly the blight killed chestnut, which is so plentiful and so frequently used.

MR. KEASBEY: How much will it increase the life of a chestnut post?

MR. PADDOCK: It should add 50% at least, with even a ten minute immersion. When there is a total immersion, such as I recommend for guard rail posts, I do not think there is any question but that it will double the life of the post. There are well authenticated cases of where a single brush treatment of one or two coats have doubled the life of fence posts.

MR. SEABROOK: In reference to your statement relative to sodium fluoride, is it applied over the protexol treatment or other the untreated wood?

MR. PADDOCK: It may be done either way. Sodium floride is not very soluble in water. You get about a 3.2% absolute saturation. It is a very weak solution. What I intended to convey was that the upper portion untreated with oil receives the treatment with sodium fluoride. We give the part of the posts in the ground an open tank treatment with protexol, and give the upper part a treatment with sodium fluoride. That is the ideal treatment, but as Mr. Bedwell says, you are going to saw off the top and in so doing saw off the best part of the treatment. The ideal treatment would be to take a brush and using the same material used on the bottom of the post, brush freely the newly cut surfaces before fastening the rails thereto. Protexol is a non-drying oil and you can squeeze the oil up after ten or fifteen years. It does not dry but stays active.

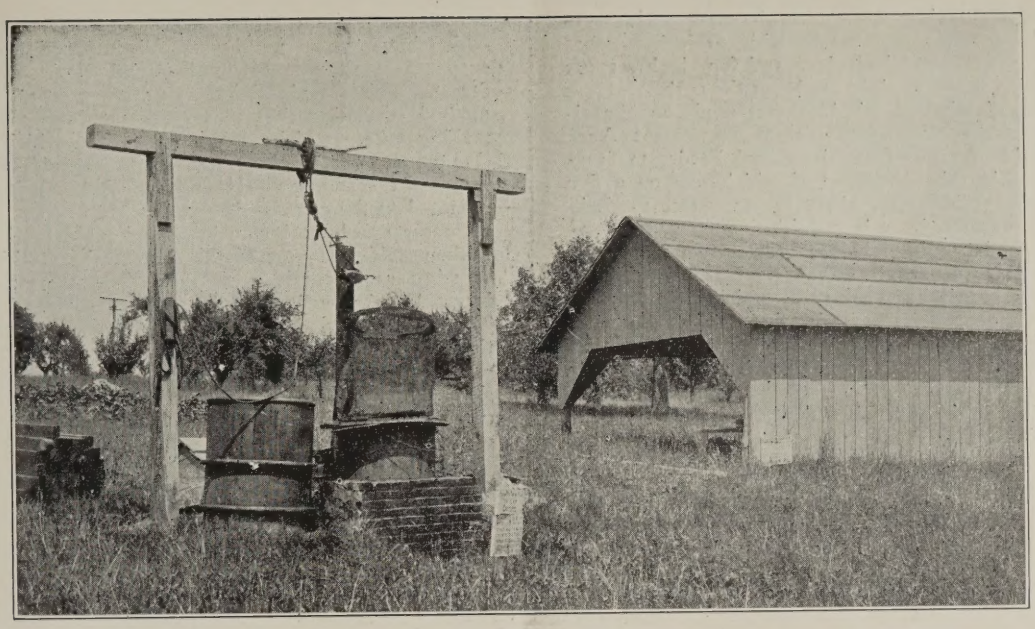
MR. KEASBEY: What effect has the presence of bark on the wood?

MR. PADDOCK: The presence of bark on any wood to be treated is absolutely to be forbidden. I am not referring now to the outerbark but to the thin inner bark. Many people think when they have scaled off the outside they have barked the post, but they have not. I have seen pilings come out of creosoting cylinders where they have been subjected to a pressure of 180-200 pounds per square inch for two or three hours, and when they were sawed into it was found that the creosote had not penetrated more than 3-16 of an inch, where patches of the inner bark had remained on the surface. It is an antiseptic placed by Nature around the tree to keep fungi from the wood. It is impervious and keeps the oil from the wood; the oil won't go through it.

COL. WHITTEMORE: What is the composition of the material you call Protexol?

MR. PADDOCK: Protexol consists of oils distilled from coal tar. That definition also applies to creosote, but up until the beginning of the war there was no anthracine oil produced in this country, or very little. In England and Germany, the tar distiller took the tar from the gas works and distilled the oils off, leaving in the retort hard pitch. He had a market for the high-boiling permanent distillate oils. They were used in the production of the anthracine dyes and alizarine dyes. Protexol is now manufactured in this country. It was simply a case of where we arrived at the point where we could not import it and learned to make it, with the result that we are now making it in New Jersey. Another reason for purchasing in Europe was that they have a market for hard pitch in making coal briquettes. In this country the distiller separates only soft pitch, which is used for roofing. Only since the beginning of the war have we had any market for anthracene oils for the anthracine and alizarine dyes and for hard pitch. Only since the beginning of the war have these high-boiling oils been produced in America.

COL. WHITTEMORE: I am very glad to get that information. I used it up to the war in a small way. I always kept one or two barrels of Protexol for use on farm buildings, cattle stables, chicken houses, and also on wood work exposed to the weather where appearance would not be considered detrimental. By treating them every year, I found it very successful, and have not been able to find a substitute since the importation was stopped by the war.



Simple equipment for treating posts in use at Massachusetts Agricultural College, Amherst, Mass. One tank mounted on a brick foundation and preservative treated by an open fire

The Advantages and Objections of a Sheet Asphalt Pavement with and without a Binder Course.

By Abram Swan, City Engineer, Trenton, New Jersey

This subject has been assigned to the speaker by the officers of this Conference and although the subject is one that the speaker has spent much time and study on, he has not satisfied himself beyond a reasonable doubt that the so-called binder course of the asphalt pavements can be dispensed with under all conditions, yet he is thoroughly convinced that asphalt pavements can and have been laid successfully without the binder course or painting of the foundation with asphalt paint. The speaker has not been able to trace the origin of the so-called binder course but has been informed that it was originated by asphalt selling companies so as to sell more asphalt.

The origin of the paint coat is as much a mystery as the binder course, but the speaker is thoroughly convinced that the paint coat on a foundation for the purpose of binding the surface thereto is nothing short of a hoax, excepting when it is applied with a high solvent and is perfectly dry, and the solvent has completely evaporated, when the wearing surface is applied, and then to be used only on a clean, dustless, and dry surface. Any soft or wet paint coat is absorbed by the hot wearing surface when applied and is really a detriment to the pavement.

The following, from Paving Economy, Road and Street, by Charles A. Mullen, Director of Paving Department, the Milton Hersey Company, Industrial Chemists, Inspectors, Consulting Engineers, Montreal, New York and Winnipeg, dated 1917, is interesting and is as follows:

"The author has never been able to locate or acquire a legitimate reason for the laying of the so-called binder course between a concrete foundation and a sheet asphalt wearing surface. The name is certainly a misnomer for the one inch thickness of crushed stone coated with asphalt cement, since this material does not and cannot bind anything.

When the so-called binder course is laid upon the concrete foundation, it does not adhere to it any more than does a sheet asphalt wearing surface laid thereon direct; which is not at all. In fact, if it did actually bind anything, that alone would be a sufficient reason for not laying it; as such a binding would be very undesirable from the maintenance point of view, and entirely unnecessary for any other reason that has yet been advanced.

The sheet asphalt wearing surface at once binds or adheres, by heat fusion, to the so-called binder course as soon as it is laid thereupon; and then the binder course becomes a permanent part of the sheet asphalt surface, and a very undesirable part.

The open binder course formerly used, was found to be an actual source of weakness, so that in recent years, it has been strengthened by a filling of sand that makes it really an asphaltic concrete intermediate course, that would act as a wearing surface by itself; though it would not be a very good one. At its best, it is a bitulithic surface, covered over with a sheet asphalt mixture, to keep it from wearing out.

As this book goes to press, it is interesting to note that the Borough of Manhattan, New York City, after making some investigations, has determined to lay several miles of sheet asphalt pavement during the present season without the so-called binder course between the concrete foundation and asphalt surface. Mr. E. W. Stern, Chief Engineer in charge of Highways, has recently advised the author to that effect."

The speaker converted Major Stern, at a convention of the American Society of Municipal Improvements at Newark, to the use of asphalts without binder and he carried out only part of his program when he entered the American Army in the World War.

For several years prior to 1911 the speaker observed and studied the various causes of and reasons for holes appearing in sheet asphalt pavements within a few years after they had been laid and discovered that a vast number of the failures were due to broken stone projections in the base of the pavement. Various types of asphalt pavement foundations have been advocated, among which it has been suggested, that the surface of the foundation be left in a rough condition with projecting stones to keep the surface from creeping.

The speaker experienced one instance on North Warren Street in this City, on which a former engineer had constructed an asphalt pavement on old Belgian block that had been taken up and laid on their sides and grouted with cement and sand grout. Apparently close inspection had been dispensed with, as a number of the blocks were not level, allowing corners to project higher than the foundation surface. Each projecting corner caused a hole in the wearing surface. The writer was of the opinion that the above mentioned failures could be eliminated, if some principal of binding the wearing surface to a smooth concrete could be accomplished. After due consideration, he

determined upon laying a concrete base, grooving the surface with a roller or tamper with projections that would create grooves one inch deep and four inches apart across the entire street, at right angles to the curb.

The first application of this idea was made on Hermitage Avenue from West State St. to Stuyvesant Ave., also on Parkside Avenue from the Canal Feeder to Stuyvesant Avenue in this city, most of which was on a five per cent grade. There were about 14,000 square yards in all. These pavements have been laid about ten years and are in very good condition today. These two pavements were observed for a period of three years, after which it was decided to lay similar pavements which have amounted to about 125,000 square yards, since 1915. Some of these have been laid on streets with very heavy traffic, such as Greenwood Avenue, from Chambers Street to City Line (State Route No. 1) from New York and Sea Shore Points to Philadelphia and points west of Trenton) Chambers Street from East State Street to Cedar Lane, South Broad Street from Liberty Street to Cedar Lane, all of which have shown no signs of distintegration or failure, except a small part of South Broad Street near Stanton Street. This creeping of the surface was due, not to the method of laying, but to an over zealous contractor in making an extra rich surface mixture in which an excessive amount of asphalt was used. In removing the surface that had creeped, it was found that the asphalt has amalgamated to the concrete base to such an extent as to form a complete and continuous bond and could not be removed without taking a part of the concrete base with it. The wearing surface where it adhered to the concrete was intact, but the top inch of the wearing surface had moved. This is the only place that has come to our notice where the concrete and asphalt had cemented together.

After ten years experience we are of the opinion that sheet asphalt pavements with a two inch wearing surface can be successfully laid on a grooved concrete base without a binder course.

Discussion of Mr. Swan's Paper

By Mr. Logan, Former Burlington County Eingineer

Mr. Swan's able paper explains the method used by the City of Trenton, that is, corrugating the concrete base and laying thereon two inches of top or "asphalt mortar". The asphalt streets of Trenton are excellent, and if such good results can be obtained without a binder course, the speaker sees no reason for such an intermediate layer.

In the early days of the construction of sheet asphalt pavements, no intermediate or binder course containing stone was used between the foundation and the top, but it was found that greater stability was obtained in the surface if it was provided. The intermediate course was first used in Washington, D. C., in 1888. During a period of nearly twenty years it consisted of a course of broken stone, three-quarters to one inch in the largest dimension, coated with bitumen and compressed. Within the last fourteen years an asphaltic concrete, consisting of a mineral aggregate of properly proportioned broken stone and sand, with an asphalt cement as a cementing material, has replaced the simple broken stone binder originally used.

The binder has stability of its own but will not withstand traffic, therefore, it is covered with a top.

The binder is less susceptible to water than bituminous mortar, as the voids are larger.

The speaker believes that all sheet asphalt should be laid with a one and one-half inch intermediate course especially where the pavement is laid on a macadam base.

General Discussion of Mr. Swan's Paper

MR. SWAN: Mr. Logan made some remarks relative to the binder course being used on macadam. There was no intention in my paper of treating this subject on macadam base. It was of a surface on concrete base. We have made successful experiments in the city of Trenton by covering our old brick pavements with an asphalt surface where we had sufficient depth of gutter. In this way we have redeemed a number of our pavements, renewing them at very little cost by using the old pavement as a base. I know of one instance where the bricks were brittle, but in a number of cases we used the asphalt on the smooth brick surface. Where we used binder, there was no perceptible creeping. In only one place of those I have reference to, out of probably 100,000 to 150,000 square yards or more laid on the smooth brick surface, on Spring Street between Calhoun and the Feeder; we skimped the binder, and where we skimped the binder, we had a rolling wavy surface. Where we placed the binder and did not skimp, we did not have this trouble. I had no intention of discussing this subject where a sheet asphalt course was used on macadam base. I merely show that to explain the matter. I agree heartily with Mr. Logan that it does not bind in that case.

MR. WILLIAMS: I would like to ask Mr. Swan whether or not he puts the top course on in one or two courses.

MR. SWAN: The top course is applied as exactly a 2 in. wearing surface of asphalt. On a 5% grade where traffic is moderate, it has proven pretty good, especially on Hermitage Avenue where we used 1½ in. above the surface of the concrete. That has been down since early in 1912.

I might supplement my remarks and say that there are several cracks which have appeared in the surface, but not any more than have appeared where the binding course has been used. In observation we have noticed that a number of those cracks were caused by the tying in of the asphalt surface by the grooves in the concrete. Where cracks occurred in the concrete, in a number of cases they showed through the surface of the wearing course. We also found that same condition to show where the binder had been used.

MR. WILLIAMS: The sample you passed around is apparently a two course construction.

MR. SWAN: Yes. This is part of the creeping, showing the adhesion of the lower edge to the surface where the top has moved. This piece was laid 2 in. thick and the top has creeped. That has occurred by traffic pushing it and evidently has brought the asphalt through to the surface. This is a one-way traffic street.

MR. ROBBINS: I would like to ask Mr. Swan a question. Have you ever noticed in any of your pavements whether the sheet asphalt surface has separated from the concrete base, that is a decided separation.

MR. SWAN: In what manner? By water getting underneath? We had an experience of this on one particular street laid on a 5% grade. On the upper end of the hill there was a failure in the concrete gutters, the water had gotten underneath, between the surface and the concrete base, separating the asphalt wearing surface from the concrete base, gradually destroying same.

MR. ROBBINS: Why has a decided rutting of the surface appeared in some streets, as South Broad Street for instance.

MR. SWAN: That was because of an excess of asphalt used in the binder. We checked up, and found, after taking the amount of material and the number of yards laid on that particular day, that the scales had been tampered with, causing an excess of asphalt in the mixture.

MR. ROBBINS: Is that true also on Parkside Avenue Hill?

MR. SWAN: No, sir. That is one of our originals, and the only failure we had was where the concrete gutters had failed, allowing the water to drain under the pavement. At this point it widened out a little along the side.

MR. ROBBINS: Have you noticed any particular waviness due to the separation from the concrete base?

MR. SWAN: Yes. This has occurred in a number of cases. We found from analysis that it was due to high penetration or to a lack of stone dust. In another instance we were somewhat non-compulssed and did not know what was the trouble with the asphalt. Later we found that a man at the plant was adding lime dust after the asphaltic cement had been applied to the hot sand aggregate or concrete.

MR. ROBBINS: Do you consider that type of construction ideal for one-way traffic?

MR. SWAN: I see no objection to it. On South Broad Street at the present time, only one portion has pushed, and not more than 3% of any one side. I would not say that it is ideal, as I think I stated in my paper the conditions would govern a whole lot. On very heavy traffic streets, I would not want to recommend it, although I personally think after my observation since 1912, that it will wear just as good as any other street with a binder under it.

MR. ROBBINS: Do you think that this type will wear as well as the old sheet asphalt type laid some years ago? I have in mind Carroll Street between State and Perry streets.

MR. SWAN: Yes. I do not see any reason why it should not. Carroll Street has not the traffic that State Street has. State Street has very heavy traffic from Warren Street to the Canal.

MR. ROBBINS: From Warren Street to the Canal, is that older than from the Canal to Clinton Street?

MR. SWAN: Yes, that was laid during the last five years.

MR. ROBBINS: When was that portion laid from Carroll Street to the entrance of the Pennsylvania Railroad Freight Station?

MR. SWAN: That has been down since 1901.

MR. ROBBINS: That was laid with a binder, was it not?

MR. SWAN: Yes. An excess of binder. We raised it particularly at that point to get an excessive crown to the street and I attribute the wearing of the paving to the excessive crown, as it shed the water.

MR. ROBBINS: That has worn very well. The old Barber Asphalt horse shoe is still in the pavement.

MR. HUBBARD: I do not want to prolong this discussion unnecessarily, but a few words in connection with the attitude of the Asphalt Association toward this question might be of interest. I believe personally that the question is an open one. There is considerable to be said in support of the use of binder, and also against the binder. I think Mr. Swan's discussion and arguments are part and parcel of the discussion introduced by Mr. Perkins, and followed by Mr. Adler, and until some of the problems shown by these two gentlemen have been solved the question of the use or discontinuing the use of binder cannot well be answered. The Asphalt Asssociation at the present time recommends the use of a 1½ in. binder course and a 1½ inch top course of sheet asphalt mixture. We do not feel that 2 in. of asphaltic mixture is as apt to prove as stable under traffic as a 1½ in. We do not feel that 1½ in. mixture alone is sufficiently thick to afford the necessary cushion for any protection when laid on a concrete base. We believe that not less than 2 in., and somewhere between 2 in. and 3 in. total thickness of asphalt construction is necessary when the pavement is laid on a concrete base and subjected to heavy travel. This is due to the presence of a cushion being necessary to protect the asphalt paving mixture itself. A 3 in. course or top would be manifestly necessary, more than the 2½ in. or 1½ in. We believe it gives the necessary stability to the pavement, and it is for this reason that at the present time we advocate its use. It may be that our idea of total thickness necessary is exaggerated, and that even 1½ in. may be proved later to be sufficiently thick. It is certain that 2 in. seems to stand well under heavy traffic not isolated. I have in mind an experiment in New York City on Lenox Avenue between 133d and 137th Streets, two blocks being laid on concrete base with a 1½ in. binder, 1½ in. top mixture, and the two adjacent blocks carrying exactly the same traffic being laid with a 2 in. sheet asphalt top on the concrete. I believe that these sections of pavements have been down for approximately 5 years and at the present date it is impossible to distinguish any difference in their wearing qualities.

Contract News

Prepared to August 24, 1922

Jan. 11—Route No. 6, Section 8, Pearl St., Bridgeton, Reinforced Concrete paving job, 0.455 miles, 20 and 30 feet wide with gravel shoulders was awarded to the Tri-State Construction Company, Bridgeton, N. J., on their low bid of $76,302.36.

Feb. 8—Route 6, Section 5, Shirley-Oldman's Creek, Reinforced Concrete Paving job, 6.812 miles, 20 feet wide with gravel shoulders, was awarded to the Benjamin Foster Company, Philadelphia, Pennsylvania, on their low bid of $254,021.53.

Feb. 16—Route 6, Section 6, Oldman's Creek-Mullica Hill, Reinforced Concrete Paving job, 5.028 miles, 20-30 feet wide with gravel shoulders, was awarded to the firm of M. Staub, Swedesboro, New Jersey, on his low bid of $203,660.48.

Feb. 24—Route 14, Section 5, Cape May Court House to Swainton, Reinforced Concrete paving job, 2.987 miles, 20 feet wide with gravel shoulders, was awarded to the firm of Sutton and Corson, Ocean City, New Jersey, on their low bid of $118,776.16.

Mar. 8—Route 6, Section 10, Quinton to Marlboro, Grading and Graveling job, 5.994 miles, 20 feet wide, with earth shoulders, was awarded to the Masterson Construction Corporation, New York City, on their low bid of $79,793.17.

Mar. 8—Route 6, Section 11, Salem to Quinton, Reinforced Concrete paving job, 2.648 miles, 20 feet wide with gravel shoulders was awarded to Joseph F. Burke, of Plainfield, New Jersey, on his low bid of $111,833.79.

Mar. 8—Route 4, Section 9, Smithville-Mullica River, Warrenite Bitulithic job, on concrete base, 3.748 miles, thirty feet wide, with gravel shoulders was awarded to C. H. Earle of Hackensack, New Jersey, on his low bid of $374,533.77.

Mar. 8—Route 10, Section 1-B, Arcadian Way to Anderson Ave. in Fort Lee, Reinforced concrete paving job, 0.48 miles, 20 and 30 feet wide with earth shoulders, was awarded to the firm of John J. McGarry, Edgewater, New Jersey, on his low bid of $104,362.61.

Mar. 15—Route 11, Section 1, Main Street, Passaic, Sheet Asphalt job, on Concrete Base, 0.257 miles, 22 feet, 2 inches wide, was awarded to Union Building Construction Company, Passaic, New Jersey, on their low bid of $15,160.15.

Mar. 23—Route 4, Section 6, Eatontown-West Long Branch, Sheet Asphalt job on Concrete Base, 2.69 miles, 20 feet wide with earth shoulders was awarded to the Utility Construction Company of New Brunswick, New Jersey, on their low bid of $149,679.74.

Apr. 4—Route 2, Section 3, South Broad Street Storm Drain job was awarded to A. G. Thompson, of Trenton, New Jersey, on his low bid of $17,665.06.

Apr. 4—Route 2, Section 3, South Broad Street, Sheet Asphalt job, on Concrete Base, 0.648 miles, 48.5 feet wide, was awarded to J. J. Barrett, Trenton, New Jersey, on his low bid of $69,433.77.

Apr. 12—Route 6, Section 9, Salem-Collier's Run, Reinforced Concrete Paving job, 4.752 miles, 20 feet wide with gravel shoulders was awarded to Sampson & Reuter, Elizabeth, New Jersey, on their low bid of $196,975.08.

Apr. 15—Route 3, Section 8, Camden-Clements Bridge Road, Reinforced Concrete Paving job, 3.82 miles, 36 and 40 feet wide with earth shoulders was awarded to W. Penn Corson, Camden, N. J., on his low bid of $269,644.85.

Apr. 15—Route 3, Section 9, Clements Bridge Road to Kirkwood, Reinforced Concrete Paving job, 3.756 miles, 29 feet wide with earth shoulders was awarded to John M. Kelley Construction Co., Camden, N. J., on their low bid of $200,592.95.

Apr. 15—Route 3, Section 10, Kirkwood-Berlin, Reinforced Concrete Paving job, 5.576 miles, 29 feet wide with earth shoulders was awarded to John M. Kelley Construction Co., Camden, N. J., on their low bid of $297,993.89.

Apr. 18—Route 15, Sections 2 and 3, Bridgeton-Millville, Warrenite Bitulithic on Concrete base, 8 miles, 20 feet wide with gravel shoulders was awarded to the Tri-State Construction Company of Bridgeton, New Jersey, on their low bid of $455,500.12.

Apr. 18—Route 4, Section 14, Laurelton-Lakewood, 3.875 miles, Reinforced Concrete Paving job, 20 feet wide with gravel shoulders was awarded to C. H. Earle of Hackensack, New Jersey, on his low bid of $144,705.68.

Apr. 19—Route 4, Section 10, Shadow Lawn-Roseld Avenue, Sheet Asphalt Paving job on Concrete Base, 2.41 miles, 20 and 36 feet wide with earth shoulders, was awarded to Newark Paving Company, of Newark, New Jersey, on their low bid of $104,969.51.

Apr. 19—Route 4, Section 12, Sea Girt Avenue, Reinforced Concrete Paving job, 0.162 miles, 20 feet wide with earth shoulders was awarded to T. H. Riddle, New Brunswick, New Jersey, on his low bid of $8,569.23.

Apr. 21—Route 9, Section 6, Somerville-Bound Brook, Reinforced Concrete Paving job, 2.491 miles, 20 feet wide, earth shoulders was awarded to Salmon Brothers, Netcong, New Jersey, on their low bid of $131,710.10.

Apr. 24—Route No. 4, Section 5-A, Storm Drain in Red Bank, was awarded to Chas. J. Romano, Montclair, New Jersey, on his low bid of $15,314.85.

Apr. 25—Route 5, Section 5, Madison Avenue, Madison Township and Borough of Madison, Warrenite Bitulithic on Concrete base, 2.032 miles, 20 feet wide with earth shoulders, was awarded to the Northern Construction Company, of Newark, New Jersey, on their low bid of $117,844.37.

Apr. 28—Route 4, Section 13, Richmond Ave., Point Pleasant Beach, Reinforced Concrete paving job, 0.848 miles, 20 feet wide with earth shoulders was awarded to C. H. Earle of Hackensack, New Jersey, on his low bid of $35,471.76.

May 9—Route 9, Section 5, Union Avenue, Bound Brook, Sheet Asphalt on Concrete Base, 1.501 miles, 20 feet wide with earth shoulders was awarded to the Utility Construction Company of New Brunswick, New Jersey, on their low bid of $93,090.31.

May 26—Route 4, Section 15, Lakewood (County Section) 2.556 miles Reinforced Concrete Paving job, twenty-eight and thirty feet wide, was awarded to the Public Service Production Company of Newark, New Jersey, on their low bid of $75,748.82.

May 26—Route 4, Section 15, Lakewood (Township Section) 2.556 miles, Reinforced concrete paving job, 36 and 50 feet wide was awarded to C. H. Earle of Hackensack, New Jersey, on his low bid of $105,741.10.

May 26—Route 9, Section 8, North Branch-Somerville, 3.837 miles, Reinforced Concrete paving job, 20 feet wide with earth shoulders was awarded to Ralph Sangiovanni, on his low bid of $159,077.59.

May 26—Route 16, Section 3, Bedminster-Plukamin, 2.415 miles Reinforced Concrete paving job, 20 feet wide with earth shoulders was awarded to Ralph Sangiovanni, on his low bid of $135,648.39.

May 26—Route 4, Section 16, Maine St., Toms River, 1.096 miles long, Reinforced Concrete paving job, 20, 30, 36, 38 and 56 feet wide with gravel shoulders was awarded to the Public Service Production Company of Newark, New Jersey, on their low bid of $62,864.59.

June 8—Route 5, Section 9, Barker's Corner-Hackettstown, 2.99 miles Reinforced Concrete paving job, 20 and 48 feet wide with earth shoulders was awarded to Frank J. Groman, of Bethlehem, Pennsylvania, on his low bid of $230,274.37.

June 8—Route 9, Section B, West Front Street, Plainfield, Sheet Asphalt paving job on Concrete Base, 1.929 miles, 40 and 41 feet wide, was awarded to the Union Paving Company, of Newark, New Jersey, on their low bid of $219,316.20.

June 10—Route 6, Section 12, East Commerce Street, Bridgeton, 1.314 miles long. Sheet Asphalt paving job on

Concrete Base, 20 and 32 feet wide, was awarded to E. K. Mixner Co., on their low bid of $80,422.01.

June 20—Route 2, Section 3-A, Whitehorse-Crosswicks Creek, 0.389 miles, Reinforced Concrete paving job, 30 and 40 feet wide was awarded to Daniel Klockner, of Trenton, New Jersey, on his low bid of $37,472.82.

June 21—Route 5, Section 6, Speedwell Avenue, Morristown, Warrenite Bitulithic surface on Concrete Base, 1.426 miles, 23 feet, 3½ inches wide was awarded to J. S. Geiger Sons of Newark, New Jersey, on their low bid of $144,892.74.

June 21—Route 9, Section 9, Phillipsburg-Still Valley, Reinforced Concrete paving job, 1.68 miles, 20 and 36 feet wide with earth shoulders was awarded to Crilly and Cannon of Phillipsburg, New Jersey, on their low bid of $110,345.40.

June 28—Route 1, Section 6, Trenton City Line-Nottingham Way, reinforced concrete paving job, 0.928 miles, 39 feet, six inches wide, was awarded to Rees and Taylor, of Trenton, New Jersey, on their low bid of $95,347.47.

June 28—Route 4, Section 11, Main Street, Avon, New Jersey, Warrenite Bitulithic surface on Concrete Base, 0.663 miles, 43 feet wide with earth shoulders was awarded to the East Jersey Bridge Company, of Perth Amboy, New Jersey, on their low bid of $54,814.34.

July 7—Route 4, Section 17, Barnegat, Reinforced Concrete job, 1.0 miles, 20 feet wide with gravel shoulders, was awarded to the Public Service Production Company of Newark, New Jersey, on their low bid of $43,931.94.

July 7—Route 4, Section 18, Tuckerton, Reinforced Concrete job, 1.5 miles, 20 feet wide with gravel shoulders, was awarded to the Public Service Production Company of Newark, New Jersey, on their low bid of $59,913.83.

July 13—Route 9, Section 7, Main Street, Somerville, Reinforced Concrete job, 0.497 miles, was awarded to J. L. Bachman of Linden, N. J., on his low bid of $74,180.25.

July 14—Route 16, Section 2, Mine Mount Road-Bedminster Corner, Reinforced Concrete job, 2.515 miles, was awarded to the Engineering Construction Corporation, Philadelphia, Pennsylvania, on their low bid of $166,802.65.

July 17—Route 9, Section 9-A, Still Valley-Bloomsbury, Reinforced Concrete job, 2.92 miles, was awarded to Bernard E. Tighe Construction Company of Easton, Pennsylvania, on their low bid of $127,785.84.

July 21—Route 5, Section 8, Great Meadows-Barker's Corner, Reinforced Concrete, was awarded to Salmon Bros., Netcong, New Jersey, on their low bid of $186,688.69.

July 25—Route 1, Section 13, Highland Park-Stelton Road, Warrenite Bitulithic on Concrete Base, was awarded to S. S. Thompson & Company, Incorporated, Red Bank, New Jersey, on their low bid of $305,394.61.

July 25—Route 1, Section 14, Stelton Road-Metuchen, Warrenite Bitulithic on a Concrete Base, was awarded to S. S. Thompson & Company, Incorporated, Red Bank, New Jersey, on their low bid of $344,784.65.

Aug. 9—Route 15, Section 4, Millville, Warrenite Bitulithic Surface on Concrete Base, 0.986 miles, 20 feet wide, was awarded to the Tri-State Construction Company, of Bridgeton, N. J., on their low bid of $55,796.67.

Aug. 10—Route 6, Section 14, Woodbury, Reinforced Concrete paving job, 1.505 miles, 20 feet wide and 46 feet wide, was awarded to the Public Service Production Company of Newark, N. J., on their low bid of $169,775.88.

Aug. 18—Route 10, Section 3, Little Ferry-Ridgefield, Reinforced Concrete job, 1.76 miles, 20 to 30 feet wide, was awarded to John J. McGarry, of Edgewater, N. J., on his low bid of $146,760.88.

Aug. 18—Route 10, Section 5, Hudson Street, Hackensack, Sheet Asphalt job, 1.449 miles, 20 ft. 4 in. and 42 ft. 6 in. wide, was awarded to G. M. Brewster, Tenafly, N. J., on his low bid of $140,205.49.

Aug. 18—Route 10, Section 5-A, Essex Street, Hackensack, Reinforced Concrete Paving job, 0.346 miles, 22 feet wide, was awarded to Ufheil and Phelan, Hackensack, N. J., on their low bid of $24,323.09.

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